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Review Article

Control and Dispersal of Bacterial Biofilms on Orthodontic Ligatures Using Plant Wealth: An Overview

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Abstract

The development of bacterial biofilms on the fixed appliances have been associated the development of white spot lesion, plaque, enamel decalcification and caries and onset of various infections. Multiple biofilm dispersal and control measures such as acid shock treatment, catheter lock solution etc. have been reviewed earlier. However, visualizing a huge pool of naturally occurring green wealth, the present precise review exclusively reminds of further intensification of more focused approach to evolve promising antibiofilm and antimicrobial biomolecules to curb oral biofilms. A large plant wealth like *Ficus retusa, Wrightia tinctoria, Terminalia catappa, Terminalia bellirica, Mentha arvensis, Alangium salviifolium, Psidium guajava, Acacia farnesiana, Cajanus cajan, Anisomeles malabarica* etc. have been explored as dental remedies for variety of dental disorders viz. toothache, foetid smell, gingivitis. However, the studies on anti-colonization potential of the plants still seems to be deficient. Further, the scientific data pool also seems to lack ample scientific documentation on plants or their biomolecules with dual antimicrobial and anti-colonization activity, especially in context to orthodontic ligature induced biofilms. Thus, there is need to trigger the targeted research efforts to explore relevant noble phytochemicals.

Keywords: *Bacterial Biofilms; Orthodontic Ligatures; Plant Wealth*

Introduction

Voluminous studies have established the development of bacterial biofilms on orthodontic ligatures during orthodontic procedures. The very onset of orthodontic treatment has been reported to elevate the bacterial populations of *Porphyromonas gingivalis*, *Streptococcus mutans*, *Streptococcus sobrinus*, *Lactobacillus casei*, *Lactobacillus acidophilus* in the saliva [1]. The fixed appliances have been said to pose high risk for the oral health leading to the development of white spot lesion, plaque, enamel decalcification and caries, and might culminate into bacteraemia and infections [2,3]. Undoubtedly, extensive efforts are being made to unravel the architectural mechanisms that build up the monomicrobial or polymicrobial communities on any given substratum. With the same propensity, the studies were also initiated to check the nefarious designs of the biofilm forming living miniatures. It is understood that the entire biofilm control mechanism rests on multipronged strategy which primarily comprises of the prevention of colonization and dispersal and disruption of the colonized formations. It has been reviewed earlier, that the multiple biofilm dispersal and control measures such as acid shock treatment, catheter lock solution, use of dispersin B and cefamandole nafate, use of genetic engineered phages, accessory gene regulation, extracellular protease, extracellular bacterial deoxyribonuclease (NucB), staphylokinase-induced plasminogen, role of Repressor of toxins (Rot), and use of various medicinal plants have been attempted [4,5]. However, there still seems to be dearth of literature showing attempts to search for the plausible solution to curb the menace of biofilms from within the available natural green wealth.

Considering a large influx of reports on microbial colonization of the orthodontic appliances by variety of microorganisms; there is need to be proactive and trigger time bound efforts to evolve efficacious antibiofilm tools to timely halt the hazardous formations. Keeping in view, a huge pool of naturally available green wealth, the present precise review exclusively attempts to call for intensification of the focused approach to evolve promising antibiofilm and antimicrobial biomolecules to curb biofilm induced risks and failures during orthodontic treatment.

Green wealth: dental disorders

Numerous medicinal plants have been explored for their remedial values for dental ailments. Plant derived antimicrobials have been studied for their role to maintain oral hygiene, eliminate oral pathogens and treat subsequent diseases [6].

The following table enlists some known traditional plants used to cure certain dental disorders [7-13].

Toothache
Ficus retusa Linn, *Wrightia tinctoria* R. Br.; *Terminalia catappa* Linn.; *Terminalia bellirica* (Gaertn.) Roxb.; *Mentha arvensis* Linn.; *Merremia tridentata* (Linn.) Hallier f.; *Monochoria vaginalis* C. Presl,; *Myrica esculenta; Phoenix sylvestris* Roxb.; *Glossogyne bidens* (Retz.) Alston.; *Hygrophila quadrivalvis* Nees,; *Jasminum ritchiei* C. B. Clarke,; *Ludwigia prostrata* Roxb,; *Majorana hortensis* Moench., *Melothria maderaspatana* (Linn.) Cogn., *Scoparia dulcis* Linn. *Hedyotis diffusa* Willd. *Laurus camphora* Linn *Origanum vulgare* Linn.: *Amorphophallus sylvaticus* (Roxb.) Kunth; *Artocarpus heterophyllus* Lam. *Barleria prionitis* Linn.; *Cinnamomum verum* J. Presl.; *Diospyros racemosa* Roxb.; *Elephantopus scaber* Linn.; *Hygrophila quadrivalvis* Nees; *Jasminum ritchiei* C. B. Clarke; *Ludwigia prostrata* Roxb; *Majorana hortensis* Moench.*Melothria maderaspatana* (Linn.) Cogn.; *Nepeta cataria* Linn.; *Nicotiana tabacum* Linn.; *Nopalea cochenillifera* (Linn.) Salm - Dyck.; *Nypa fruticans* Wurmb.; *Osbeckia crinita* Benth.; *Plantago major* Linn.; *Solanum aculeatissimum* Jacq.; *Spilanthes calva* DC.; *Tabernaemontana divaricata* R. Br. Ex Roem. & Scult.; *Tabernaemontana heyneana* Wall.; *Terminalia chebula* Retz.; *Xanthium strumarium* Linn.; *Zanthoxylum limonella* (Dennst.) Alston
Fetid Smell
Alangium salviifolium Wang., *Carmona microphylla* G. Don, *Cocos nucifera* Linn., *Jatropha curcas* Linn., *Jatropha gossypifolia* Linn. *Cassia ja*
Caries Cavity
Commiphora myrrha (Nees) Engl.*; Ficus retusa* Linn
Bleeding Gum
Kirganelia reticulate Baill *Terminalia bellirica* (Gaertn.) Roxb. *Psidium guajava* Linn.; *Acalypha indica* Linn; *Phyllanthus multiflorus* Willd.*; Piper betle* Linn.; *Plantago major* Linn.; *Symplocos racemosa* Roxb.
Gingivitis
Acacia farnesiana (Linn.) Willd. *Cajanus cajan* (Linn.) Millsp. *Acalypha indica* Linn; *Cleome chelidonii* Linn. f.; *Salvia officinalis* Linn.; *Tephrosia purpurea* (Linn.) Pers.
Stomatitis
Cajanus cajan (Linn.) Millsp.; *Canscora diffusa* (Vahl.) R. Br.; *Coccinia grandis* (Linn.) Voigt.; *Coscinium fenestratum* Colebr.; *Erythrina variegata* Linn.; *Gymnema sylvestre* R. Br.; *Symplocos racemosa* Roxb.; *Vernonia cinerea* Less.; *Vitex altissima* Linn. f.
Gum Disorder
Acacia ararbica Willd, *Achyranthes aspera* Linn., *Cyperus rotundus* Linn*., Ficus benghalensis* Linn. *Toddalia aculeata* Pers. *Solanum surattense* Burm. *F; Ximenia americana* Linn. *Morinda citrifolia* Linn.; *Terminalia chebula* Retz.
Mouth Ulcer
Jatropha curcas Linn., *Jatropha gossypifolia* Linn.; *Portulaca oleracea* Linn.; *Solanum nigrum* Linn.
Fever during Teething
Anisomeles malabarica (Linn.) R. Br.

Table 1: *Some important plants with remedial potential.*

However, plants like *Achras zapota* Linn., *Albizia lebbek* Benth., *Argemone mexicana* Linn., *Cordia obliqua* Willd, *Croton tiglium* Linn., *Eclipta prostrata* Linn. *Holarrhena antidysenterica* Wall., *Lannea coromandelica* (Houtt.) Merrill, *Ligustrum indicum* (Lour.) Merrill, *Pterocarpus marsupium* Roxb., *Solanum anguivi* Lam., *Soymida febrifuga* Juss., *Trichosanthes nervifolia* Linn. have been documented for general dental ailments.

Green wealth: Anti colonization potential

The studies, however negligible, have been carried out on the potential use of plant wealth against microbial colonization. Following table enlists a few natural plant resources explored for their antibiofilm potential.

S. No.	Plant	Target Bacterial Biofilm
1	Tea, Hop Bract, *C. longa*	[*Streptococcus mutans*] [14-20]
2	*Lentinus edodes*,	[*Streptococcus mutans, Actinomyces naeslundii, Prevotella intermedius*] [21,22]
4	Caatinga	[*Staphylococcus epidermidis, Pseudomonas aeruginosa*] [23]
5.	*Cinchona*, *Alnus japonica*	[*Staphylococcus aureus*] [24,25]
6.	*Coffea canephora*	[*Streptococcus mutans, Streptococcus sobrinus*] [26,27]
7	*Glycyrrhiza glabra, Quercus infectoria*	[*Pseudomonas aeruginosa*] [28]
8	*Azadirachta indica, Vitex negundu, Tridax procumbens, Ocimum tenuiflorum*	[*E. coli*] [29]
9	*Garlic Ointment*	[*Staphylococcus aureus, Staphylococcus epidermidis, Pseudomonas aeruginosa, Acinetobacter baumannii Klebsiella pneumonia, Enterococcus faecalis, S. aureus, S. epidermidis* and *A. baumannii*] [30]

Table 2: *Plants with anti-biofilm potential.*

Attempts have also been made to determine the phytochemical constituents of various medicinal plants. As documented in various reviews and research outcomes, simple phenols (Catechol, Epicatechin); Phenolic acids (Cinnamic acid); Quinones (Hypericin); Flavonoids (Chrysin); Flavones (Abyssinone); Flavonols (Totarol); Tannins (Ellagitannin); Coumarins (Warfarin), Terpenoids, essential oils (Capsaicin); Alkaloids (Berberine, Piperine); Lectins and polypeptides (Mannose-specific agglutinin, Fabatin); Polyacetylenes 8S-Heptadeca-2(*Z*), 9(*Z*)-diene-4,6 have been reported to possess antimicrobial activities [31]. Further to it, polyphenols, procyanidins, coumarins, steroids and terpenes; α-turmerone, germacrone, α-zingiberene, αr-turmerone, trans-β-elemenone, curlone), and β-sesquiphellandrene; alkaloids, quercetin and tannic acid; 6-Gingerol, cinchona alkaloids have been found to associate with the plants possessing activity in inhibition or dispersal of bacterial biofilms [20,24,25,28,30,32-34]. Oxalic acid, succinic acid, quinic acid and adenine, inosine and uridine were identified by HPLC-DAD-ESI-MS/MS and studied for their antibiofilm potentials [22]. Earlier studies on anti-adhesive mode of action of purified *Lentinus edodes* extract showed that Low Molecular mass fraction (LMM) homogenate interfered with binding of *Streptococcus mutans* to hydroxyapatite and *Prevotella intermedia* to gingival cells [35].

Conclusion

As cited above, there is a vast green wealth with their potential as dental remedies. However, there is dearth of literature presenting the scientific data on plants or their biomolecules for their potential authentic role in inhibition, dispersal or disruption and control of biofilms and their subsequent applications on orthodontic ligatures. Moreover, the scientific data pool further seems to lack ample scientific documentation on plants or their biomolecules with dual antimicrobial and anti-colonization activity. Thus, keeping in view the detrimental effects of the biofilms on orthodontic ligatures during orthodontic treatment, there is need to trigger the targeted research efforts to explore noble phytochemicals with scientifically proven dual anti colonization and antimicrobial activities.

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